

Sub 11

1. (Twice amended) A heat exchanger, assembly comprising:
- a semiconductor chip;
 - a heat conducting plate having a first surface positioned adjacent said semiconductor chip;
 - a circular chamber positioned above a second surface of the heat conducting plate;
 - a plurality of heat conducting fins disposed within the circular chamber;
 - a fluid aperture positioned at a central portion of the of the circular chamber, configured to direct fluid entering the chamber to impinge against the second surface of the plate; and
 - a fluid aperture positioned at a peripheral region of the circular chamber.

2. The heat exchanger of claim 1 wherein the plurality of fins are positioned in a generally radial direction extending from a central region of the circular chamber towards a peripheral region;

3. The heat exchanger of claim 1 wherein the fins are arranged in a spiral pattern, each fin extending from a central area of the chamber out toward a peripheral portion of the chamber.

4. The heat exchanger assembly of claim 1 wherein the circular chamber comprises an overhead wall and there is at least one annular channel recessed upwardly into the overhead wall.

6. The heat exchanger of claim 3 wherein each fin extends laterally from a leading edge to a trailing edge with the trailing edge being closer to the peripheral portion of the circular chamber, and the fin being laterally curved in the direction of the spiral pattern

7. The heat exchanger of claim 3 wherein an outer perimeter of the circular chamber is defined by the inside surface of an annular wall, and there is at least one annular space in the chamber proximate the annular wall, between a trailing edge of the fins and the annular wall.

8. The heat exchanger of claim 7 wherein an overhead wall of the circular chamber has at least one annular fluid channel recessed upwardly into the wall.

9 The heat exchanger of claim 8 wherein the annular channel of the overhead wall has a varying cross sectional area with the area being greatest at a distance furthest from the fluid outlet aperture and the area being at a minimum adjacent the fluid outlet aperture.

10. The heat exchanger of claim 1 wherein the fins are arranged in at least two concentric circular arrays, comprising at least an inner array and at least an outer array, each circular array comprising a plurality of fins arranged in a generally radial pattern with each fin extending from a leading edge of the fin to a trailing edge of the fin, the trailing edge being positioned radially outward of the leading edge closer to a peripheral region of the circular chamber.

11. The heat exchanger of claim 10 wherein the fins of each circular array are arranged in a spiral pattern, each fin have a leading edge and a trailing edge, with the trailing edges of the fins being positioned closer to a peripheral region of the circular chamber than leading edges.

12. The heat exchanger of claim 10 wherein the circular chamber has at least two annular space regions, with at least a first annular space being between the inner array and outer array of fins, and at least a second annular space being between the outer array of fins and an inside surface of an annular wall of the chamber.

13. The heat exchanger according to claim 12 wherein an overhead wall of the circular chamber has at least one annular fluid channel recessed upwardly into the wall, the annular fluid channel being disposed over at least one of the annular space regions in the circular chamber.

14. The heat exchanger of claim 13 wherein the annular fluid channel has a varying cross sectional area, the cross sectional area being greatest at a distance along the channel furthest from the fluid outlet aperture and at a minimum adjacent the fluid outlet aperture.

15. The heat exchanger of claim 2 wherein an outer portion of the circular chamber, has a varying cross sectional area.

16. The heat exchanger of claim 15 wherein the cross section area of the outer portion of the chamber is greatest at a position diametrically opposed to the position of the fluid outlet aperture.

17. The heat exchanger of claim 2 wherein the fluid inlet aperture is positioned in overhead wall of the circular chamber at the center of the wall and the fluid outlet aperture is positioned in the overhead wall at the periphery of the wall.

18. A heat exchanger for cooling a device, comprising:

a heat conducting surface;

a fin plate in contact with the heat conducting surface, and having two concentric circular arrays of fins, comprising an inner array and an outer array, each circular array comprising a plurality of fins arranged in a generally radial pattern, extending outward from an inner region of the respective array toward an outer region thereof;

an annular wall extending upwardly from the fin plate;

an overhead wall with a recessed annular channel, the overhead wall, the fin plate and the annular wall defining a fluid chamber of the heat exchanger;

a fluid inlet aperture disposed at the center of the overhead wall; and

a fluid outlet aperture disposed at the periphery of the overhead wall.

19. The heat exchanger of claim 18 wherein the fins are curved in a radial pattern into a spiral shape.

20. The heat exchanger of claim 18 further comprising a conduit chamber disposed above the overhead wall of the fluid chamber, the conduit chamber housing a outlet conduit connecting the fluid outlet aperture to an opening on the outside wall of the chamber, and further housing an inlet conduit connecting the fluid inlet aperture to an opening on the outside wall of the conduit chamber.

21. The heat exchanger of claim 20 wherein the conduit chamber is a cylinder.

22. The heat exchanger of claim 21 wherein an external fitting is threadedly engaged to the outlet conduit through the corresponding opening on the outside wall of the cylinder and an external fitting is threadedly engaged to the inlet conduit through the corresponding opening on the outside wall of the cylinder, the fittings being configured to mate with external conduits for transferring fluid to and from the heat exchanger.

29. (Twice Amended) A method for cooling a semiconductor chip, comprising:

impacting a cooling fluid against the central region of a plate within a circular chamber;

distributing the fluid through the chamber;

withdrawing heat from the semiconductor through the plate and into the fluid;

discharging the fluid through an outlet aperture located at a peripheral portion of the circular chamber; and

attaining even distribution of the fluid throughout the circular chamber as it flows towards the periphery of the chamber by equalizing pressure drop for substantially equal flow rates, from the center of the plate, in any radial direction, to the fluid outlet aperture of the chamber, by varying the fluid velocity of the fluid about the periphery of the circular chamber, and by increasing the fluid velocity as it approaches the fluid outlet aperture.

30. The method according to claim 29 wherein distribution of the fluid through the chamber comprises directing the fluid in a generally radial direction to the periphery of the circular chamber.

31. The method according to claim 29 wherein distribution of the fluid through the chamber comprises directing the fluid in a spiraling direction from the center of the plate towards the periphery of the circular chamber.

35. The method according to claim 31 wherein equalizing the pressure drop comprises varying the cross sectional area of an outer portion of the circular chamber.

36. The method of claim 29 further comprising increasing an individual heat transfer coefficient of the fluid by increasing turbulence and reducing boundary layer thickness of the fluid on a wall within the circular chamber by changing momentum of the fluid.

37. The method of claim 36 wherein changing the momentum of the fluid comprises directing the fluid in a curved spiral flow pattern.

38. The method of claim 29 further comprising attaining uniform distribution of the fluid through the chamber by spreading the fluid in a generally radial direction and reducing back pressure against the radial flow.

39. The method of claim 38 wherein reducing the back pressure against the radial flow comprises imparting rotational velocity to the fluid on the outer perimeter of the chamber.

40. The method of claim 29 further comprising attaining uniform distribution of the fluid through the chamber by spreading the fluid in a generally radial direction and creating a low pressure zone about the periphery of the chamber.

41. The method of claim 29 further comprising reducing boundary layer thickness on a heat transfer surface by introducing a space between two heat transfer walls wherein fluid communication with the walls is momentarily broken while the fluid travels between the walls.

42. The method of claim 29 further comprising increasing the overall heat transfer area by providing a curved heat transfer surface.

43. A heat exchanger for a semiconductor chip comprising:
a heat conducting surface;
a circular chamber positioned above the heat conducting surface;
a fluid inlet aperture in the circular chamber;
a fluid outlet aperture in the circular chamber.

a plurality of heat conducting fins disposed within the circular chamber and arranged in at least two concentric circular arrays, comprising at least an inner array and at least an outer array, each circular array comprising a plurality of fins arranged in a generally radial pattern with each fin extending from a leading edge of the fin to a trailing edge of the fin, the trailing edge being positioned radially outward of the leading edge closer to a peripheral region of the circular chamber; and

wherein the circular chamber has two annular space regions, with a first annular space being between the inner array and outer array of fins, and a second annular space being between the outer array of fins and an inside surface of an annular wall of the chamber.

44. The heat exchanger according to claim 43 wherein an overhead wall of the circular chamber has at least one annular fluid channel recessed upwardly into the wall, the annular fluid channel being disposed over at least one of the annular space regions in the circular chamber.

45. The heat exchanger according to claim 43 wherein an overhead wall of the circular chamber has an annular fluid channel recessed upwardly into the wall and having a varying cross sectional area; the cross sectional area being greatest at a distance along the channel furthest from the fluid outlet aperture and at a minimum adjacent the fluid outlet aperture, the annular fluid channel being disposed over at least one of the annular space regions in the circular chamber.

46. A heat exchanger for a semiconductor chip comprising:
a heat conducting surface;
a circular chamber positioned above the heat conducting surface;
a fluid inlet aperture positioned at a central portion of the of the circular chamber; and
a fluid outlet aperture positioned at a peripheral region of the circular chamber;
and
an outer portion of the circular chamber having a varying cross sectional area, wherein the cross section area of the outer portion of the chamber is greatest at a position diametrically opposed to the position of the fluid outlet aperture.